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Impact of Gastrostomy Tube Placement on Short-Term Weight Gain in Hospitalized Premature Infants

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Abstract

Background: Gastrostomy tube (G-tube) placement is a long-term alternative to oral or nasogastric feeding for premature infants, who cannot safely feed orally or need supplemental nutrition for adequate growth.

Materials and Methods: We compared daily weight changes for G-tube infants 14 and 30 days pre- and post-placement, excluding the first 7 days post-G-tube insertion, were compared. Infants <37 weeks gestation without major congenital anomalies discharged from 327 United States neonatal intensive care units (2004–2013) were included. Incidence of in-hospital outcomes including hypoxic ischemic encephalopathy, intraventricular hemorrhage grade 3 or 4, necrotizing enterocolitis, and patent ductus arteriosus ligation was examined. Additionally, we estimated a treatment effect model, in which infants with G-tube were matched 1:1 to untreated controls based on propensity scores; main outcome was the average treatment effect (weight gain) for treated infants during the 7, 14, or 30 days immediately prior to discharge.

Results: 1,393/329,254 (0.4%) infants received a G-tube, increasing from 0.2% in 2004 to 0.6% in 2013. Daily weight gain was significantly less during days 8–14 post-placement compared to 14 days pre-placement, but similar between 30 days pre- and days 8–30 post-placement. After matching, G-tube infant weight gain during the 7 days pre-discharge was less than among controls, but there was no difference in weight gain between treated and control patients for 14 and 30 days pre-discharge.

Conclusions: The prevalence of G-tube placement has increased. G-tube use in infants was not associated with improved short-term daily weight gain.

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Keywords

premature infants; gastrostomy tube; weight gain

Introduction

Providing the necessary nutrition to infants admitted to neonatal intensive care units (NICUs) can be challenging, due to associated morbidities, slow progression of feeding skills in premature infants, the development of oral aversion, parental issues related to feeding premature infants, and specific breastfeeding issues in this population. Thus, providers increasingly view gastrostomy tube (G-tube) placement as an important long-term alternative to oral or nasogastric feeding for medically complex children, including premature infants, who cannot safely feed orally or need supplemental nutrition for adequate growth. Between 1997 and 2009, G-tube placement in the United States increased from 16.6 to 18.5 per 100,000 hospitalized children.¹

Prior data suggest that G-tube placement can be beneficial and have a significant impact on the nutritional status, growth, and development of medically complex patients.^{2–4} For example, in children with neurologic disability, G-tube placement may improve outcomes, including decreased antibiotic use and respiratory-related hospitalizations, mainly due to reductions in the risk of aspiration.⁵ Weight changes in premature infants following G-tube placement in the neonatal period have not been described.

We conducted this study in premature hospitalized infants to evaluate weight changes before and after placement of a G-tube, and to compare the weight gain prior to hospital discharge between infants with and without G-tubes.

Methods

Data Source and Study Population

We obtained data from the Pediatrix Medical Group Clinical Data Warehouse, which prospectively captures clinical information entered into an electronic health record by clinicians at 327 NICUs in the United States.⁶ We extracted data on infants, including demographics, diagnoses, and other aspects of clinical care, including the presence of a G-tube and postnatal age at the time of procedure.

We included all inborn infants born <37 weeks gestational age (GA) and discharged alive between 2004 and 2013. We excluded infants with major congenital anomalies, and infants with incomplete daily weight data. We collected the following infant characteristics: sex, race, birth weight (BW), daily weight, GA at birth, and postnatal age at the time of G-tube placement. We also noted the following clinical outcomes: the presence of hypoxic ischemic encephalopathy, intraventricular hemorrhage (IVH) grade 3 or 4, any necrotizing enterocolitis (NEC; medical and surgical), bronchopulmonary dysplasia (BPD), and surgical intervention for a patent ductus arteriosus (PDA). We extracted maternal data on prenatal care and delivery type. We extracted data on hospital length of hospital stay (in days) and

daily weights (in grams) for up to thirty days before and after G-tube placement or discharge.

Definitions

We defined an infant with G-tube as any infant meeting the inclusion and exclusion criteria who underwent placement of a G-tube during the NICU hospitalization. We defined BPD based on gestational age: infants <32 weeks GA were classified as having BPD if they received supplemental oxygen or respiratory support (nasal cannula, continuous positive airway pressure, or mechanical ventilation) after a corrected GA of 36 0/7 weeks; infants 32 weeks GA at birth were classified as having BPD if they received supplemental oxygen or respiratory support (nasal cannula, continuous positive airway pressure, or mechanical ventilation) continuously from a postnatal age of beyond 28 days.⁸ All medical and surgical NEC diagnoses were included in the analysis.⁹

Statistical Analysis

We summarized the distributions of continuous and categorical variables using medians (25th, 75th percentiles) and counts (%) respectively. We documented the trend of G-tube use during the study period. We determined the proportion of infants with G-tube placement and used standard summary statistics and graphing techniques to describe study variables for all infants, stratified by the presence or absence of G-tube. We examined the incidence of in-hospital outcomes including hypoxic ischemic encephalopathy, IVH grade 3 or 4, NEC, and PDA ligation.

To better assess the effects of G-tubes on weight gain in premature infants, we performed two different analyses. First, we focused only on infants who received G-tubes, using linear regression to compare daily changes in weight for each infant before G-tube placement with that patient's weight gain after placement (where procedure day was day "0"). This analysis was done separately for the 14-day window before and after placement, as well as the 30-day window before and after. Since we observed acute changes in weight during the immediate post-procedure period (Figure 1), we excluded the first seven days after placement from the regression analysis for both time frames. Thus, we estimated daily weight for G-tube patients as a function of time for the 14 (or 30) days before placement and for days 8 to 14 (or 8 to 30) after placement, to minimize the possibility that the post-placement trend would be influenced by the immediate post-placement weight changes.

In a second analysis, we estimated a treatment effect model, in which G-tube infants were matched 1:1 to untreated controls based on propensity scores. The main outcome was the average treatment effect (weight gain) for treated infants during the 7, 14, or 30 days immediately prior to discharge. To be included in the secondary analyses, the infants with G-tubes must have had their placement at least 7, 14, or 30 days prior to discharge, respectively. Estimated propensity scores were based on BW, GA, length of stay in the NICU, race, sex, NEC, PDA ligation, IVH, BPD, and site.

This study was approved by the Duke University Institutional Review Board. Statistical analysis was performed using Stata version 14.1 (College Station, TX). We considered a p-value <0.05 as statistically significant.

Results

We identified 329,254 infants who met the study's criteria. Of these, 1,393 (0.4%) received a G-tube during the study period. The infants with a G-tube in this cohort were more premature (63% of infants were born <28 weeks) and 59% were extremely low BW (<1000 g BW), while 91% of infants without G-tubes were born after 28 weeks, and only 7% of them were extremely low BW (Table 1). The proportion of infants with G-tubes increased from 50/23,749 (0.2%) in 2004 to 215/35,847 (0.6%) in 2013 (Figure 2). The median (25th, 75th percentiles) BW and GA for the infants receiving a G-tube were 872 (660, 1355) g and 27 (25, 30) weeks, respectively. The median (25th, 75th percentile) length of stay was 125 (93, 155) days. The median (25th, 75th percentile) postmenstrual age at the time of G-tube placement was 42 (40, 45) weeks. The most common comorbidity was BPD (65%), followed by PDA ligation (23%), NEC (13%), and IVH grade 3 and 4 (12%). The incidence of hypoxic ischemic encephalopathy in our cohort was 1%.

Daily weight data for at least 14 days pre- and post-placement was available for 372 infants with G-tubes (Figure 1). The daily weight gain during days 8–14 post-placement was significantly less than observed during the 14 days prior to placement, 18 g/day versus 28 g/day, $p<0.001$. When we extended the pre- and post-placement data to 30 days, this negative association between G-tube placement and weight gain was no longer present, 24 g/day versus 26 g/day ($p=0.20$), but only 88/1,393 (6%) infants were in the hospital at least 30 days before and 30 days after G-tube placement.

On propensity score matching (Table 2), the infants with G-tubes gained less weight per day than did the controls (21.1 g/day versus 24.3 g/day, $p<0.001$) during the last 7 days before discharge ($N=1,111$ infants in each group). However, for the longer periods of 14 days ($N=608$ infants in each group) or 30 days ($N=237$ infants in each group) prior to discharge, there were no statistical differences in daily weight gain between G-tube infants and controls (Table 3).

Discussion

Our investigation is the largest reported to date analyzing the changes in weight for 1,393 hospitalized premature infants with G-tube placement. For NICU infants who cannot feed or take medications by mouth, G-tubes represent a safe way of administering nutrition and medications for long periods of time. In our study, we showed that after the placement of a G-tube, infants may take more than 2 weeks to gain weight at rates seen prior to the procedure. We observed that there is an immediate surge in weight after G-tube placement, followed by weight *loss*, with an eventual return to a pattern of weight gain seen prior to placement (Figure 1). The immediate post-placement weight fluctuations may be due to fluid management during and after the surgery, as well as the different management strategies in the initiation of feeds after new G-tube placement.

G-tube placement was not associated with improved short-term weight gain in our cohort of hospitalized, premature infants. This finding is consistent with previous findings in infants with congenital diaphragmatic hernia, where G-tubes were not associated with improved

growth.¹⁰ Nevertheless, in populations with special medical conditions that predispose to poor growth and nutrition such as ultra-short gut, Pierre Robin syndrome, and cystic fibrosis, G-tube placement has been associated with improved weight gain.^{11–13}

Children with neurodevelopmental disabilities have been the most-studied population with apparent long-term benefits of growth and quality of life associated with G-tube placement.^{14–17} Weight gain and appropriate growth occur more frequently in this population when G-tube placement occurs early, before morbidities and malnutrition become evident.^{18,19} Importantly, studies of children with neurodevelopmental disabilities include not only in-hospital, but also post-discharge data. Weight gain in these complex populations has been most notable over longer periods of time and in those with milder underlying disease.¹³ In this study, we were unable to observe premature infants beyond hospital discharge, and more than half of our cohort remained admitted for less than two weeks after G-tube placement.

Our study had several notable strengths. We used data from the Pediatrix Clinical Data Warehouse, which allowed us to identify a large and representative sample from across the United States. We examined 1,393 premature infants with G-tubes, were able to include information on daily documented weights, and use data from more than 300 NICUs across the country with diverse infant management practices.

Despite these strengths, our study had a number of limitations, most of which relate to the retrospective observational design. First, the indication for G-tube placement in this group was not available. Second, weight evolution is directly related to nutrient ingestion, and in the present study, we did not have access to the method of administration of feeds and medications prior to the placement of a G-tube (oral versus nasogastric tube versus intravenous), daily caloric intake or type of feedings (breast milk versus formula), or infants' oral feeding skills at the time of surgery. In this case, G-tube placement may have facilitated stable feeding post-discharge rather than a method for increasing feeding volume or caloric density. Information on feeding protocols, post-op feeding tolerance, and fasting prior to G-tube placement was not available for this study. Finally, we could only evaluate weight changes during the hospitalization because none of the infants had post-discharge follow-up data available to us.

While G-tube placement for infants in our study resulted in no significant effect on short-term weight gain during hospitalization, placement of a G-tube may have additional benefits not captured by our study. Previously identified benefits include safety of administration of nutrients, fluids, and medications, as well as facilitation of discharge plans, including parental comfort and decreased stress regarding the long-term nutritional status of a child.^{20–22} In this study, we focused on differences in short-term weight gain between premature infants who did and did not receive a G-tube prior to initial hospital discharge; however, more studies are needed to further clarify the indications for the G-tube placement, reasons for increase in G-tube placement, and the impact of G-tubes on long-term feedings and quality of life for this population. Future studies with more follow-up data on former NICU infants may be able to better evaluate the growth trends post-discharge, and the duration of G-tube utilization in premature infants with and without neurodevelopmental disabilities.

Conclusion

In this cohort of hospitalized premature infants, G-tube use increased over time. Among infants with G-tubes, there was no difference in weight gain in the period before and after placement. In addition, in the period prior to discharge, infants with G-tubes had similar or less weight gain relative to matched controls.

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Clinical Relevancy Statement

Providers are increasingly viewing gastrostomy tube (G-tube) placement as an important long-term alternative to oral or nasogastric feeding for infants discharged from the neonatal intensive care units (NICUs). We conducted the largest evaluation to date analyzing the changes in weight for 1,393 hospitalized premature infants with G-tube placement. We observed that there is an immediate surge in weight after G-tube placement, followed by weight loss, with an eventual return to a pattern of weight gain seen prior to placement. Prior to discharge, infants with G-tubes had similar or less weight gain relative to matched controls. Future studies with more follow-up data on former NICU infants may be able to better evaluate the weight gain post-discharge, and the duration of G-tube utilization in premature infants with and without neurodevelopmental disabilities.

Figure 1.

Mean daily weight before and after G-tube placement

This figure displays the mean daily weight 14 days before and after G-tube placement on 372 preterm infants with G-tubes. Each point represents the average daily weight of all infants with G-tube for that day before and after the surgery (day 0).

G-tube, gastrostomy tube

Figure 2.

G-tube placement over time

This figure displays G-tube placement in premature infants discharged from one of the Pediatrix Medical Group NICUs between 2004 and 2013.

G-tube, gastrostomy tube; NICU, neonatal intensive care unit

Table 1.

Patient characteristics, (%)

Characteristics	Infants with G-tube (N=1,393)	Infants without G-tube (N=327,861)
GA at birth, weeks		
25	33	2
26–28	30	7
29–32	21	24
33–36	16	67
BW category, g		
<1000	59	7
1000–1499	20	14
1500–2499	14	58
2500–3499	5	19
3500	2	32
Race/ethnicity		
White	48	53
Black	29	20
Hispanic	16	21
Other	7	6
Male	53	54
Cesarean section	75	63

BW, birth weight; GA, gestational age; G-tube, gastrostomy tube

Table 2.

Matched cohort at 7 days prior to discharge, mean (SD) or N (%)

Characteristics	Infants with G-tube (N=1111)	Matched controls (N=1111)
GA at birth, weeks	27.8 (3.7)	27.3 (3.5)
BW, g	1107 (706.0)	1015 (588.5)
Race/ethnicity		
White	511 (46.0)	394 (47.7)
Black	339 (30.5)	233 (28.2)
Hispanic	186 (16.7)	136 (16.5)
Other	75 (6.8)	63 (7.6)
Male	0.5 (0.5)	0.5 (0.5)
NEC	0.1 (0.3)	0.1 (0.3)
IVH grade III or IV	0.1 (0.3)	0.1 (0.3)
PDA ligation	0.2 (0.4)	0.3 (0.4)
BPD	0.7 (0.5)	0.7 (0.4)

BPD, bronchopulmonary dysplasia; BW, birth weight; GA, gestational age; G-tube, gastrostomy tube; IVH, intraventricular hemorrhage; NEC, necrotizing enterocolitis; N, number; PDA, patent ductus arteriosus; SD, standard deviation;

Table 3.

Average daily weight gain prior to discharge in G-tube patients and propensity score-matched controls

Days before discharge	Number of infants per group	Weight gain (g/day)		Difference (g/day)	p-value
		G-tube	Non-G-tube		
7	1111	21.1	24.4	-3.2	<0.001
14	608	23.2	22.9	+0.3	0.68
30	237	24.8	23.0	+1.8	0.13

G-tube, gastrostomy tube